Freshwater Ecosystems

SECTION 1

Objectives

- Describe the factors that determine where an organism lives in an aquatic ecosystem.
- Describe the littoral zone and the benthic zone that make up a lake or pond.
- Describe two environmental functions of wetlands.
- Describe one threat against river ecosystems.

Key Terms

wetland
plankton
nekton
benthos
littoral zone
benthic zone
eutrophication

The types of organisms in an aquatic ecosystem are mainly determined by the water's *salinity*—the amount of dissolved salts the water contains. As a result, aquatic ecosystems are divided into freshwater ecosystems and marine ecosystems.

Freshwater ecosystems include the sluggish waters of lakes and ponds, such as the lake shown in **Figure 1.1**, and the moving waters of rivers and streams. They also include areas where land, known as a **wetland**, is periodically under water. Marine ecosystems include the diverse coastal areas of marshes, bays, and coral reefs as well as the deep, vast oceans.

Characteristics of Aquatic Ecosystems

Factors such as temperature, sunlight, oxygen, nutrients, and the nature of the bottom determine which organisms live in which areas of the water. For instance, sunlight reaches only a certain distance below the surface of the water, so most photosynthetic organisms live on or near the surface.

Aquatic organisms are grouped by location and by their adaptations. There are three groups of aquatic organisms. **Plankton** are organisms that cannot swim against currents, so they are drifters. Drifting algae, called *phytoplankton*, are the food base for most aquatic ecosystems. Most phytoplankton are microscopic. Drifting animals, which may be microscopic or as large as a jellyfish, are called *zooplankton*. **Nekton** are free-swimming organisms, such as fish and whales. **Benthos** are bottom-dwellers, such as mussels, worms, and barnacles. Many benthic organisms live attached to hard surfaces or burrow into softer sediments. Decomposers, which break down dead organisms, also live in aquatic ecosystems.

FIGURE 1.1

Freshwater Ecosystems Lake Louise in Alberta, Canada, is an example of a freshwater ecosystem.

FIGURE 1. 2

Pond Dwellers Amphibians, such as this bullfrog, live in or near lakes and ponds.

Lakes and Ponds

Lakes, ponds, wetlands, rivers, and streams make up the various types of freshwater ecosystems. Lakes, ponds, and wetlands can form naturally where groundwater reaches the Earth's surface. As well, beavers can create ponds by damming up streams. Humans intentionally create artificial lakes by damming flowing rivers and streams to use them for power, irrigation, water storage, and recreation.

Life in a Lake

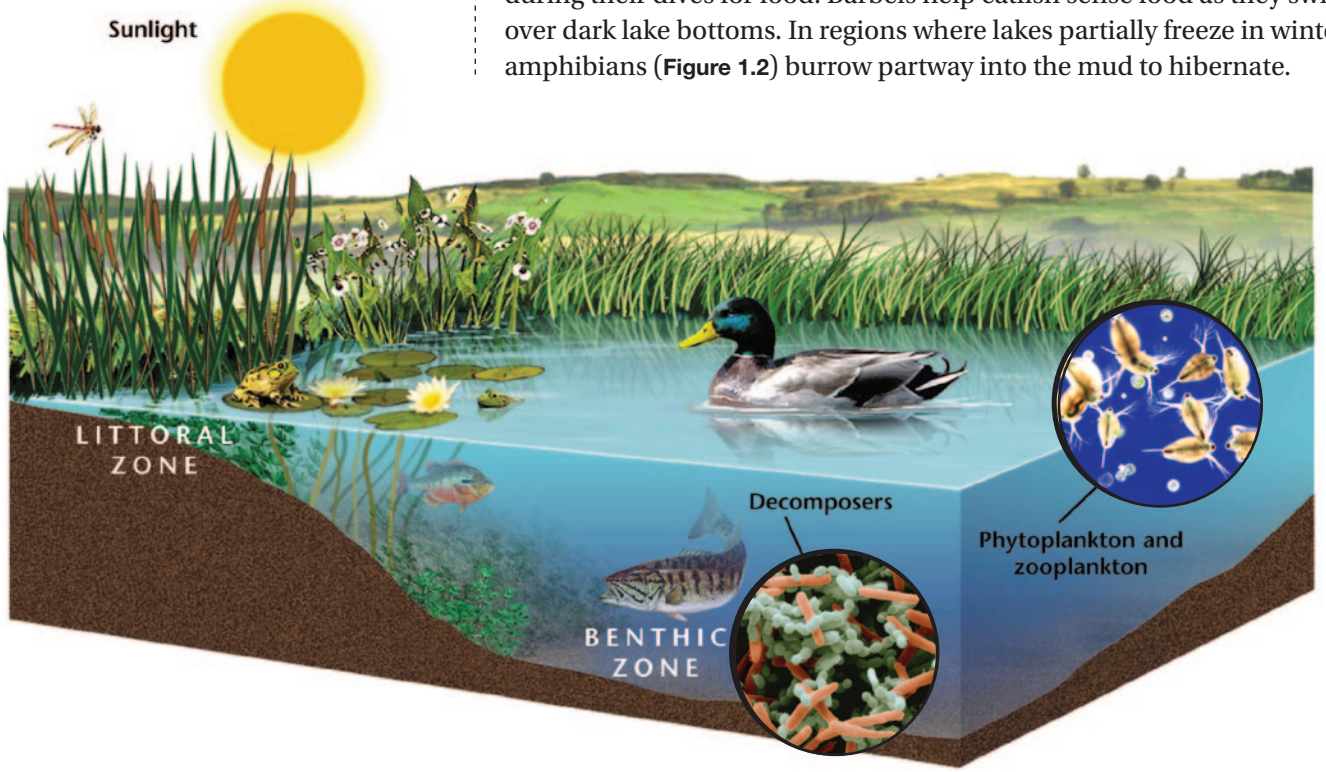
Lakes and ponds can be structured into horizontal and vertical zones. In the nutrient-rich **littoral zone** near the shore, aquatic life is diverse and abundant. Plants, such as cattails and reeds, are rooted in the mud underwater, and their upper leaves and stems emerge above the water. Plants that have floating leaves, such as water lilies, are rooted here also. Farther from the shore, in the open water *limnetic zone*, there are no rooted plants. Here, phytoplankton make their own food by *photosynthesis*. As shown in **Figure 1.3**, nutrients and sunlight influence the location and types of organisms in a pond or lake ecosystem.

Some bodies of fresh water have areas so deep that there is too little light for photosynthesis. In these deep areas, bacteria and other decomposers live on dead plants and animals that drift down from above. Fish adapted to cooler water also live there. Eventually, dead and decaying organisms reach the **benthic zone**, the bottom of a pond or lake, which is inhabited by decomposers, insect larvae, and clams.

Some animals that live in lakes and ponds have interesting adaptations that help them obtain what they need to survive. Water beetles use the hairs under their bodies to trap surface air so that they can breathe during their dives for food. Barbels help catfish sense food as they swim over dark lake bottoms. In regions where lakes partially freeze in winter, amphibians (**Figure 1.2**) burrow partway into the mud to hibernate.

FIGURE 1.3

Surface Life In a pond or lake ecosystem, the most diverse and abundant life occurs near the shore, where sunlight and nutrients are plentiful. In the open water, sunlight at and near the surface supports drifting phytoplankton.



How Nutrients Affect Lakes

Nutrients in aquatic ecosystems determine the amount of plant and algal growth. **Eutrophication** is an increase in the amount of nutrients. Lakes with large amounts of algae and plant growth from excessive nutrients are *eutrophic lakes* (**Figure 1.4**). As the plants and algae multiply, the number of bacteria feeding on the decaying organisms also grows. These bacteria use the oxygen dissolved in the lake water. Eventually, the reduced amount of oxygen kills oxygen-loving organisms. Lakes naturally become eutrophic over time, but the process can be accelerated by runoff. *Runoff* is precipitation that can carry pollutants like fertilizers from land into bodies of water.

FIGURE 1. 4

Eutrophication A eutrophic lake, like the one below, contains large amounts of plants as a result of high levels of nutrients.

Freshwater Wetlands

Freshwater wetlands are areas of land, with special soils and plants, that are covered with fresh water for at least part of the year. The two main types are marshes and swamps. *Marshes* contain nonwoody plants, such as cattails, while *swamps* are dominated by woody plants, such as flood-tolerant trees and shrubs.

Wetlands perform several important environmental functions (**Figure 1.5**). Wetlands act as filters or sponges because they absorb and remove pollutants from the water that flows through them. Therefore, wetlands improve the water quality of lakes, rivers, and reservoirs downstream. Wetlands also control flooding by absorbing extra water when rivers overflow, which protects farms and urban and residential areas from damage. Many of the freshwater game fish caught in the United States each year use the wetlands for feeding and spawning. In addition, wetlands provide a home for native and migratory wildlife, including ducks and blue herons (**Figure 1.6**). Wetland vegetation also traps carbon that would otherwise be released as carbon dioxide, which has been linked to rising atmospheric temperatures.

CHECK FOR UNDERSTANDING

Explain How can wetlands reduce damage that is caused by flooding?

FIGURE 1.5

ENVIRONMENTAL FUNCTIONS OF WETLANDS

trapping and filtering sediments, nutrients, and pollutants, which keep these materials from entering lakes, reservoirs, and oceans
reducing the likelihood of a flood, protecting agriculture, roads, buildings, and human health and safety
buffering shorelines against erosion
providing spawning grounds and habitat for commercially important fish and shellfish
providing habitat for rare, threatened, and endangered species
providing recreational areas for activities such as fishing, birdwatching, hiking, canoeing, photography, and painting

FIGURE 1.6

Wetland Dwellers Wetlands provide habitat for many plants and animals, including the great blue herons shown below.

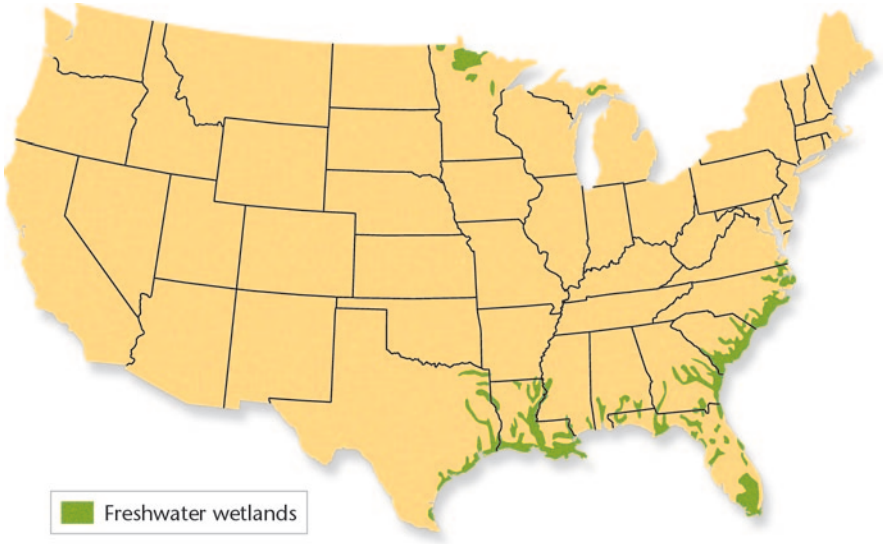
Connect to HISTORY

The Florida Everglades

Because of the work of many writers, conservationists, and naturalists, former U.S. President Truman dedicated the Everglades National Park in 1947. The park was established to protect the wildlife and habitat of the Florida Everglades. The Florida Everglades is one of only three sites on Earth declared an International Biosphere Reserve, a World Heritage Site, and a Wetland of International Importance. The other two sites are located in Tunisia and Bulgaria.

FIGURE 1. 7

U.S. Wetlands This map shows the locations of large freshwater wetlands in the United States, which constitute less than half of those present in the 1600's.



Marshes

As shown in **Figure 1.7**, most large freshwater wetlands in the United States are located in the Southeast. The Florida Everglades is the largest freshwater wetland in the United States. Freshwater marshes tend to occur on low, flat lands and have few, if any, woody trees or plants. In shallow waters, plants such as reeds, rushes, and cattails root themselves in the rich bottom sediments. As shown in **Figure 1.8**, the leaves of these and other plants stick out above the surface of the water year-round.

The benthic zones of marshes are nutrient-rich and contain plants, algae, many types of decomposers, and scavengers. Waterfowl, such as grebes and ducks, have flat beaks adapted for sifting through the water for fish and insects. Water birds have spear-like beaks that they use to grasp small fish and to probe for frogs buried in the mud. Marshes are also home to migratory birds from temperate and tropical habitats.

The salinity of marshes varies. Some marshes have fresh water, some have slightly salty (brackish) water. Salt marshes have water that is as salty as ocean water. The organisms that live in and around a marsh are generally adapted to the specific range of salinities of the marsh's water.

FIGURE 1.8

Marsh A marsh is a type of wetland that contains nonwoody plants.

CRITICAL THINKING

Compare How is a swamp different from a marsh?

Swamps

Swamps occur on flat, poorly drained, wooded land, often near streams. The species of trees and shrubs in a swamp depend on the salinity of the water and the climate of the area. Freshwater swamps include acidic *bogs,* filled with sphagnum or peat moss, which are found in colder climates, and cypress swamps, which are found in warmer areas. These, along with alkaline *fens*, are the ideal habitat for many amphibians, such as frogs, because of the continuously moist environment. Swamps also attract birds, such as wood ducks that nest in hollow trees near or over the water. Reptiles, like the American alligator in **Figure 1.9**, are the major predators of swamps and will eat almost any organism that crosses their path.

FIGURE 1.9

Swamp The American alligator is a common reptile that lives in marshes and swamps.

Human Impact on Wetlands

Wetlands were previously considered to be wastelands that provided breeding grounds for disease-carrying insects. Many have been drained, filled, and cleared for farms or residential and commercial development, as shown in **Figure 1.10**. For example, the Florida Everglades once covered 8 million acres of south Florida, but now covers less than 2 million acres. The important role of wetlands as purifiers of wastewater and in flood prevention is now recognized. Wetlands are vital habitats for wildlife. The federal government, as well as international treaties, protect many wetlands, and most U.S. states now prohibit the destruction of certain wetlands.

Connect to MATH

Wetland Conversion

From 1982 to 1992, approximately 1.6 million acres of wetlands on nonfederal lands in the United States were converted for other uses. Fifty-seven percent of the wetlands were converted into land for development. Twenty percent of the wetlands were converted into land for agriculture. How many acres of land were converted into land for development? How many acres of land were converted into land for agriculture?

FIGURE 1.10

Wetland The wetland on the right has been drained for agricultural purposes. Wetlands such as this typically serve as breeding areas for ducks. The oil rig on the left is located in a marsh along the coast of Louisiana.

FIGURE 1.11

Water Flow A river changes dramatically as it flows from a mountaintop to flat land.

CHECK FOR UNDERSTANDING

Predict What effect can runoff have on the health of organisms that live in and around a river?

Rivers

Rivers can originate from underground springs, snow melt in mountains, or where smaller streams merge together. At its headwaters, a river is usually cold and full of oxygen and runs swiftly through a shallow riverbed. Further along, it becomes warmer, wider, and slower, containing more vegetation and less oxygen. **Figure 1.11** compares the water flow of two sections of two different rivers. A river changes with the land and the climate through which it flows. Runoff, for example, may wash nutrients and sediment from the surrounding land into a river, which eventually drains into the ocean. These materials affect the growth and health of the organisms in the river.

Life in a River

Near the headwaters, mosses anchor themselves to rocks by using rootlike *rhizoids.* Trout and minnows are also adapted to the cold, oxygen-rich waters. Trout are powerful swimmers and have streamlined bodies that present little resistance to the strong current. Downstream, in the calmer waters, plants such as the crowfoot set roots in the river's rich sediment. Fish such as catfish and carp thrive where the water slows and deepens.

Rivers in Danger

Communities and industries affect the health of rivers. People draw water from rivers to use in homes and manufacturing. People also use rivers to dispose of their sewage and garbage. These practices have polluted rivers with toxins. The toxins have killed river organisms and have made river fish unsuitable for eating. Today, runoff from the land deposits pesticides and other poisons into rivers and coats riverbeds with toxic sediments. In addition, dams alter the ecosystems in and around a river.

Section 1 Formative Assessment

Reviewing Main Ideas

1. **List** two factors that determine where an organism lives in an aquatic ecosystem.
2. **Compare** the littoral zone of a lake with the benthic zone of a lake.
3. **List** two environmental functions that wetlands provide. How do these functions affect you?
4. **Describe** one threat against river ecosystems.

Critical Thinking

5. **Identifying Relationships** A piece of garbage that is thrown into a stream may end up in a river or an ocean. What effects might one piece of garbage have on an aquatic ecosystem? What effects might 100 pieces of garbage have on an aquatic ecosystem?
6. **Analyzing Processes** Write a short paragraph that explains how fertilizing your yard and applying pesticides can affect the health of a river ecosystem.